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(54) Height control of air-suspended vehicles

(57) Air suspended vehicles, for example trailers, are frequently fitted with an air suspension system which selectively permits inflation/deflation of the suspension to level the load platform with a dock for loading/unloading. Damage can occur to the suspension and its shock absorbers if the suspension is not returned to normal ride height before, or on, leaving the dock.

Selector 8 is operated to pass pressure air from supply 23 to the pilots of valves 65, 66 so isolating the height control valve(s). This enables inflation of the suspension via valves 111, 113 and pipes 38, 42, or deflation by operation of valves 112, 114, also via pipes 38, 42 and pipe 121.

Service brake actuation energises solenoid valve 67 via cable 69 from the vehicle brake light circuit so that valve 8 is reverted by pressure air at its pilot, allowing valves 65, 66 to revert. The suspension is now restored to control by the height control valve(s) which effect restoration of the suspension to its normal ridge height. Alternatively, valve 8 may be reverted by direct application of brake line pressure.

Each side of the suspension may be inflated/deflated independently.

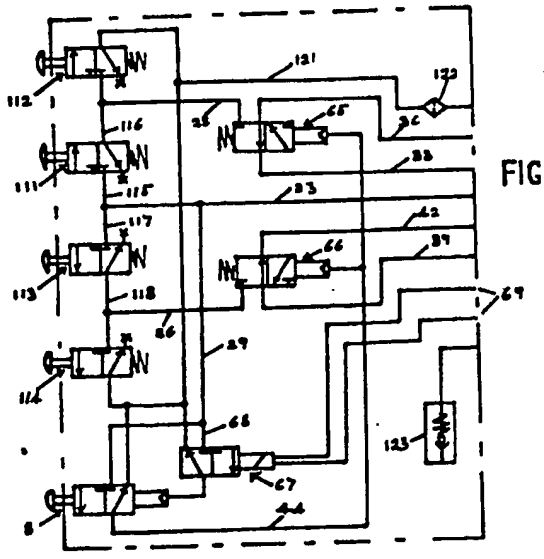

FIGURE 9

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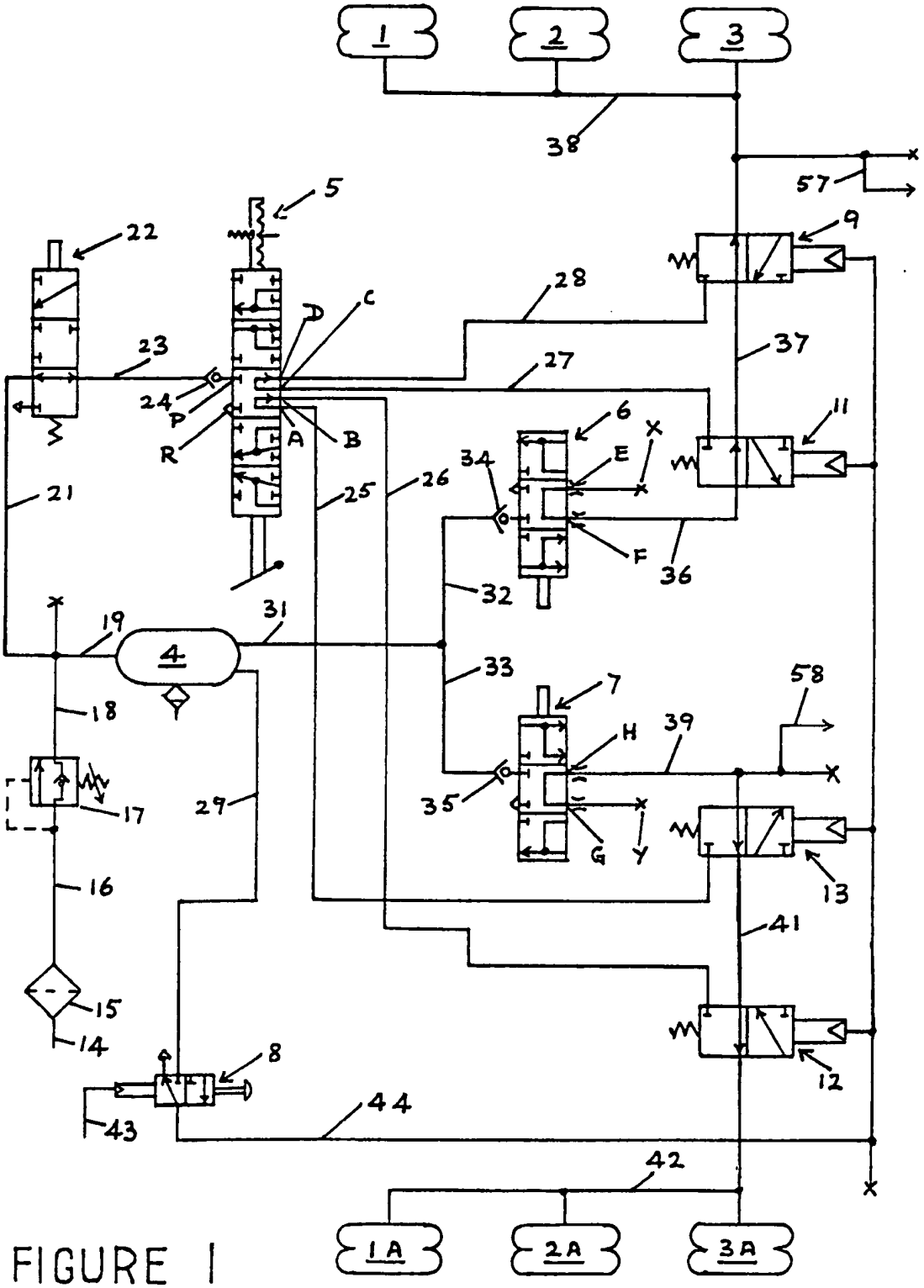
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FIGURE 1

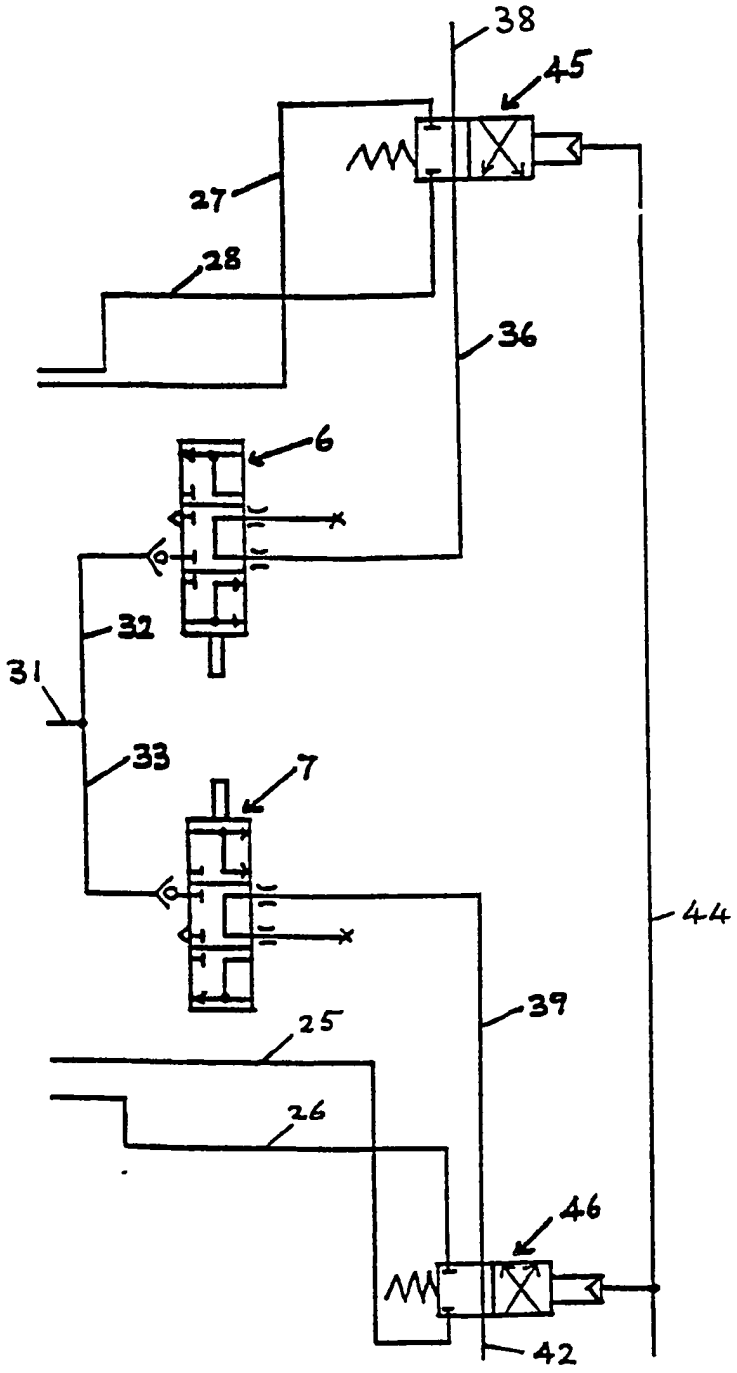


FIGURE 2

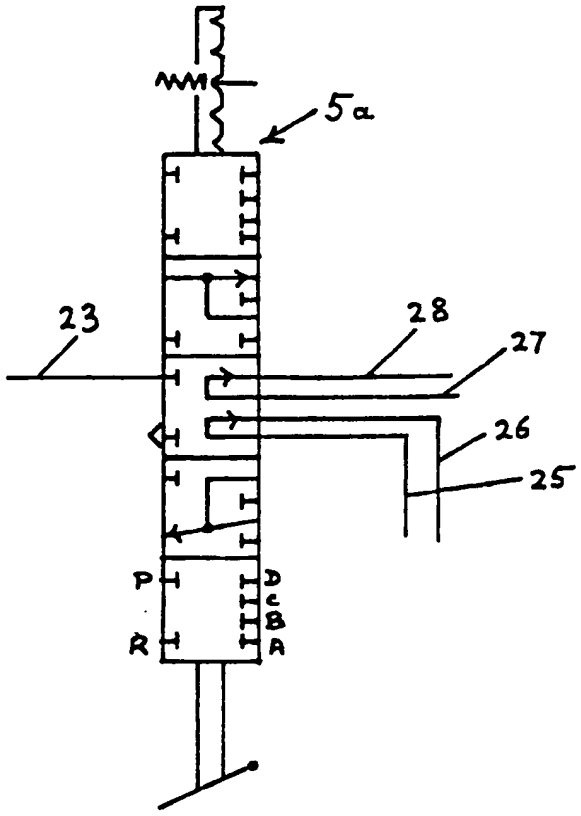


FIGURE 3

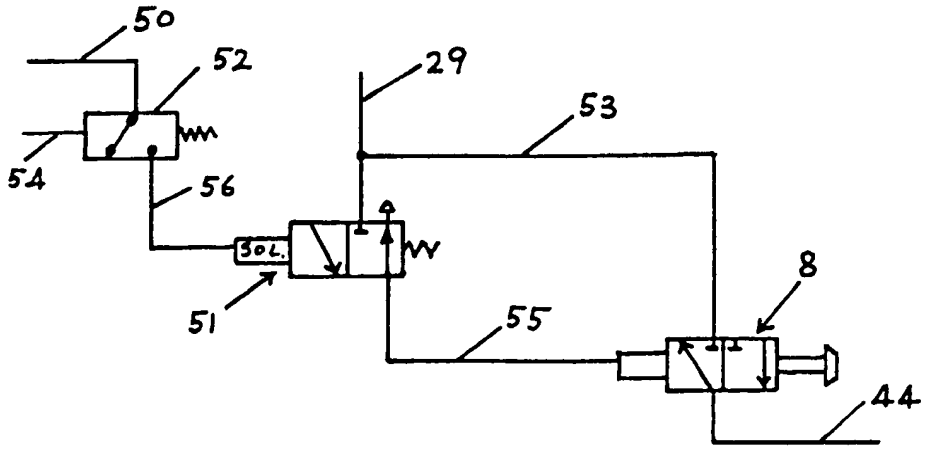
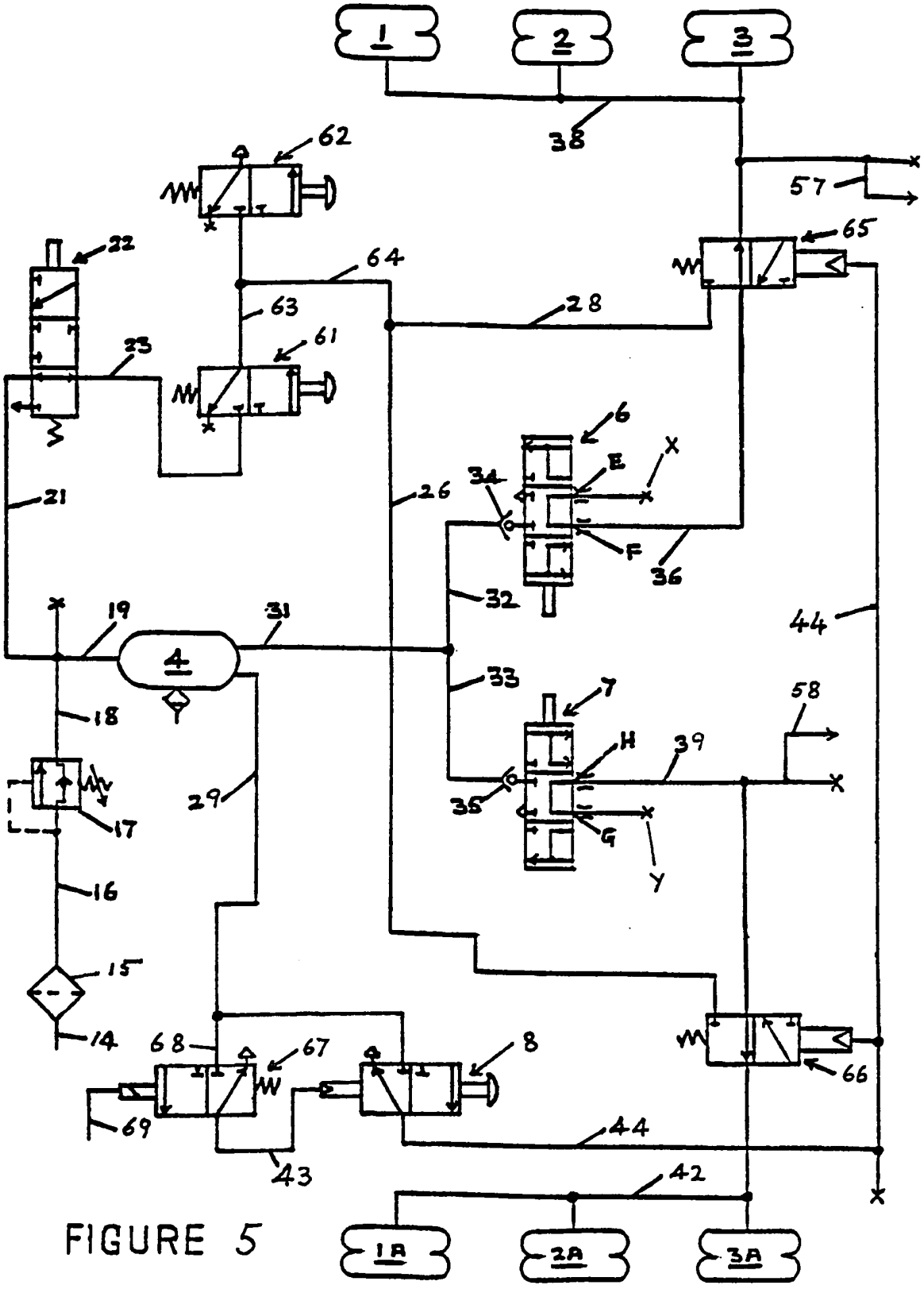


FIGURE 4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4
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58
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H
39
29
35
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16
15
14
68
67
8
66
69
44
43
42
1A
2A
3A

FIGURE 5

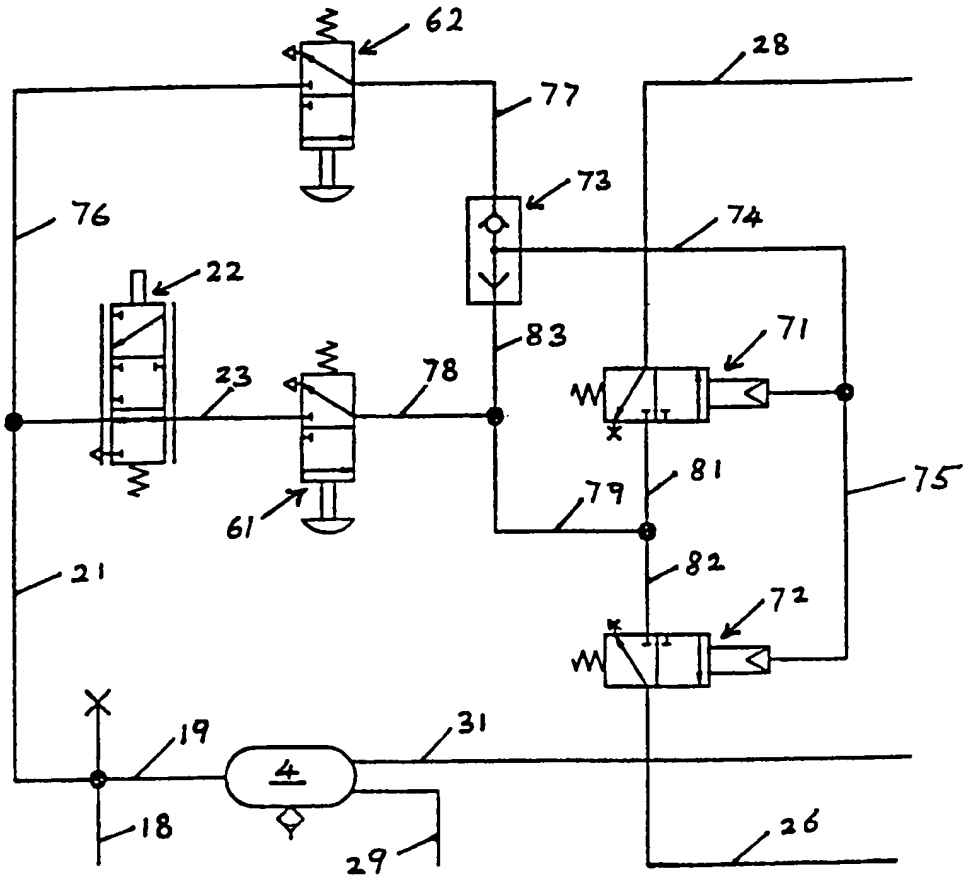
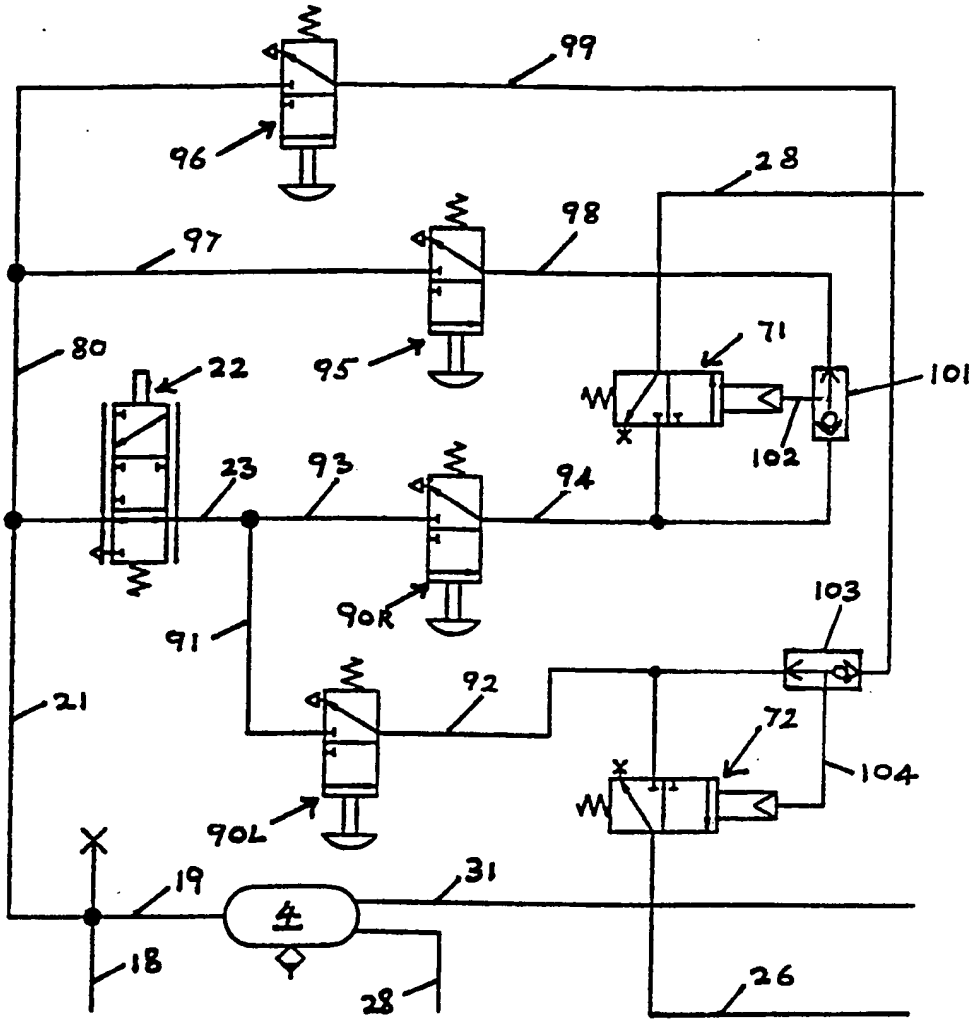


FIGURE 6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90R
103
91
92
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72
104
90L
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FIGURE 7

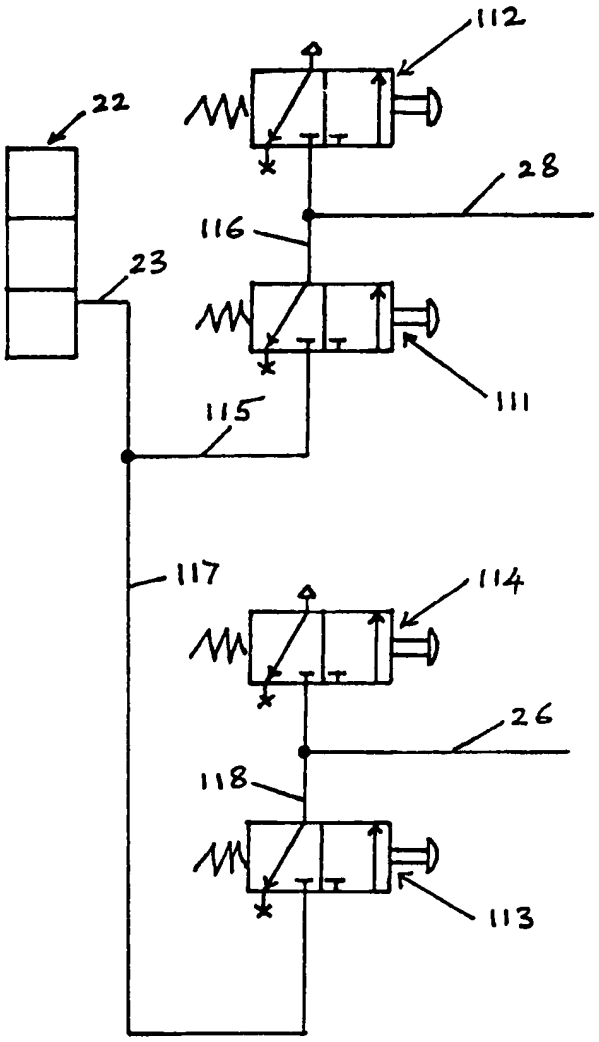

FIGURE 8

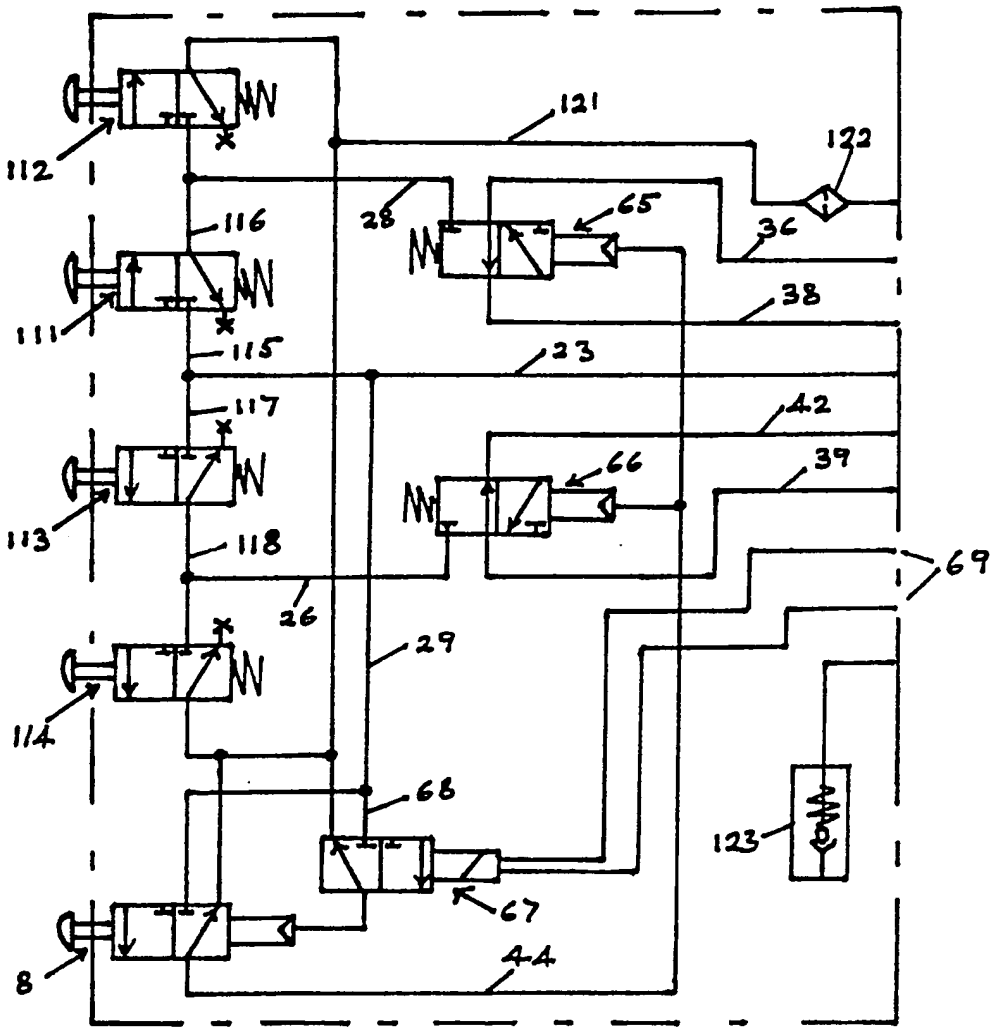
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FIGURE 9

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Height Control of Air Suspended Vehicles

This invention relates to air suspension systems for load carrying vehicles and to load carrying vehicles incorporating air suspension systems. In such systems and vehicles there is provided at least one height control valve operatively connected, or adapted to be connected, between the vehicle and one axle, and pneumatically connected to a source of pressure air and to the air springs. As the axle to vehicle distance is varied, depending on the loading of the vehicle, the height control valve operates to admit pressure air to, or exhaust air from, the air springs to restore the vehicle-to-axle distance to its design value. In multi-axle installations provision is made for equalising the loads on the axles by interconnecting the air springs at each side of the vehicle. When such a vehicle enters a loading bay or dock (hereafter referred to as a dock) to be loaded or unloaded it is frequently the case that the vehicle platform height is different from that of the dock. Accordingly, the air suspension system has provision (conventionally known as a Raise/Lower valve) for overriding, or by-passing, the height control valve so that the vehicle platform height can be adjusted, by raising or lowering, to equate with the height of the dock. Generally, where the vehicle is a trailer, the tractor will remain coupled to the trailer whilst the loading/unloading operation is carried out so that the dock can be vacated without delay to accept the next vehicle. However, this is not necessarily so and the tractor may be uncoupled from the trailer when the latter has been docked.

If the vehicle platform height has been raised or lowered on docking, the operator should operate the system to restore the vehicle platform height to its normal ride height before moving the vehicle from the dock. If, however, he fails to do so, damage can be caused to the suspension system and/or to its shock absorbers. The air suspension system described is hereafter referred to as an air suspension system of the type described.

The purpose of this invention is to make provision in an air suspension system of the type described for ensuring that the air suspension is restored to its normal ride height condition when a vehicle to which the system is fitted is moved following a raise or lower operation of the vehicle platform.

According to one aspect of the present invention an air suspension system of the type described comprises in pneumatic circuit first valve means adapted to be connected to a pressure air supply and connected via second valve means to the air springs, the second valve means also connected to height control valve means whereby in a first condition of the second valve means the air springs are enabled to be inflated/deflated via the height control valve means and in a second condition of the second valve means the air springs are connected to the first valve means whereby the air springs may be inflated/deflated, remote operating means to cause the second valve means to be operated to the second condition, and a selector valve adapted to be connected to a pressure air supply and connected to the second valve means for remote operation thereof when said selector valve is operated to a first condition and means to operate said selector valve to a second condition whereby said second valve means is enabled to revert to its first condition in which inflation/deflation of the air springs is controlled by the height control valve means.

The selector valve may be a pilot operated valve, the pilot being pneumatically or electrically operated to operate the selector valve to its second condition. If a pneumatic pilot, it may be connected to a brake line, for example a service brake line, of a vehicle to which the system is fitted whereby the pilot is actuated when the brake is applied. If the pilot is electrically operated the electrical power or signal may be derived from a brake light circuit of the vehicle to which the system is fitted whereby the pilot is actuated, directly - or indirectly, for example via an electrically operated pneumatic valve - when the brake is applied.

The system may be arranged to permit inflation/deflation of the air springs on each side of a vehicle to which the system is fitted independently so permitting lateral levelling of the vehicle platform if the vehicle is resting on unlevel ground.

According to another aspect of the present invention a trailer comprises an air suspension system of the type described and as set out herein.

According to a further aspect the invention comprises a kit of parts for the purpose set out.

The invention will now be described by way of example only with reference to the accompanying drawings in which:

Figure 1 is a circuit diagram of an air suspension system for a tri-axle installation incorporating one design of second valve means,

Figure 2 shows schematically a second design of second valve means for use in the circuit of Figure 1,

Figure 3 shows schematically an alternative type of first valve means which may be substituted for the first valve means in the circuit of Figure 1,

Figure 4 shows schematically an alternative method of operating the selector valve of the circuit of Figure 1,

Figure 5 is a circuit diagram similar to Figure 1 incorporating further alternative first and second valve means and a further alternative method of operating the selector valve,

Figures 6, 7 and 8 are part circuit diagrams showing further alternative first valve means for use in the circuit of Figure 5 and

Figure 9 is a schematic diagram showing one arrangement of valves in a control box

Referring to the drawing Figure 1, a trailer (not shown) has three axles, each suspended by two air springs, shown at 1, 1A; 2, 2A; and 3, 3A. The trailer has the usual pressure air reservoir 4, a Raise/Lower valve 5 (the first valve means) having ports, A, B, C, D, P and R, to which further reference will be made. Two height control valves 6, 7, a manually operated selector valve 8 and second valve means, shown as comprising two 3-way pilot operated spring return valves, 9, 11 and 12, 13 for the air springs on each side of the trailer, are provided.

A pressure air supply is provided, for example from a tractor to which the trailer is connected, via a brake reservoir (not shown), a pipe 14 a filter 15 and a pipe 16 to a pressure protection valve 17 and from there via pipes 18, 19 and 21 to the reservoir 4 and to a height limiting valve 22. The height limiting valve 22 (connected between the trailer chassis and an axle) has been included as this is required on some, but not all, trailer platform raising installations to limit the height to which the platform can be raised by cutting supply of pressure air to the Raise/Lower valve. A pipe 23 connects valve 22 to Raise/Lower valve 5 at port P via an optional check valve 24. Port R of valve 5 exhausts to atmosphere and ports A, B, C, D are connected respectively to valves 13, 12, 11 and 9 by pipes 25 to 28 respectively.

The reservoir 4 is connected by a pipe 29 to valve 8 and to the height control valves 6, 7 via pipes 31, 32, 33 and respective check valves 34, 35. Valve 6 is connected to valve 11 via pipe 36, valve 11 is

connected to valve 9 by pipe 37 and valve 9 is connected to air springs 1, 2 and 3 by pipes referenced 38. Similarly valve 7 is connected to valve 13 via pipe 39, valve 13 is connected to valve 12 by pipe 41, and valve 12 is connected to air springs 1A, 2A, 3A by pipes referenced 42.

Valve 8 is reset by a pilot which is connected by pipe 43 to a pressure air supply. This supply may, for example, be from the supply to the trailer service brake whereby an application of the trailer service brake causes valve 8 to revert to, or remain in, the condition shown in Figure 1. Valve 8 is connected by pipes referenced 44 to the pilots of the valves 9, 11, 12, 13.

Referring now to Figure 2, the 3-way valves 9, 11 and 12, 13 are replaced by one 4 way valve in each case, referenced 45 and 46. These are also pilot operated and spring return.

Figure 3 shows schematically an alternative construction of Raise/Lower valve 5a. This differs from the valve 5 in that in the Raise Stop and Lower Stop conditions (respectively the upper and lower "boxes") the ports A, B, C and D are all blocked whereas in valve 5 the ports A and C are connected to atmosphere via port R in the Raise Stop condition and in the Lower Stop condition the ports A and C are connected to pressure air via port P.

The operation of the system will now be described. Referring again to Figure 1, it is assumed the various valves are in the conditions shown with the trailer platform at its normal ride height, a tractor is connected to the trailer and the combination is parked on the tractor brake, that is, pipe 43 is not pressurised, and reservoir 4 is charged with pressure air. If the tractor engine is running its compressor will be supplying pressure air to the trailer air suspension system via pipe 14 and filter 15.

It is desired to raise the trailer platform to level with a dock. Valve 8 is operated manually to admit pressure air from reservoir 4 through valve 8 and pipes 44 to the pilots of valves 9, 11, 12 and 13 whereby these valves change over. Valve 5 is then operated manually to the Raise Condition (second "box" from the top). Pressure air now passes from reservoir 4 and/or the tractor compressor through valve 22 and ports P, D and B of valve 5 whence it passes through valves 9 and 12 to the air springs 1, 2, 3 and 1A, 2A, 3A, extending them.

When the trailer platform rises to the desired height the valve 5 is selected to the Raise Stop condition (top "box"). Ports B and D are now blocked, sealing the pressure air in the air springs and ports A and C, which had been blocked, are now connected to port R and atmosphere. It will have been seen that the operation of valves 11 and 13 consequent on operation of valve 8, has disconnected the height control valves 6, 7 from their respective air springs, whereby the normal height control mechanism has been by-passed.

In the normal course of events the operator should either select the "Ride" condition (middle "box") with the Raise/Lower valve 5 or reset valve 8 manually before driving the trailer away from the dock. If he does the former, the ports A and B will be connected and also the ports C and D, and if he does the latter the valves 9, 11, 12 and 13 will revert. The valves 6, 7 will be in their "Lower" conditions (top and bottom "boxes" respectively). In either case the air springs will exhaust to atmosphere via the
valves 6, 7 until valves 6, 7 revert to the mid selection as the trailer platform lowers to the normal ride height.

If the operator selects "Ride" with valve 5 but fails to reset valve 8 then valves 9, 11, 12, 13 remain in the operated condition. The air springs will still exhaust via valve 9, valve 5, valve 11 and valve 6

and via valve 12, valve 5, valve 13 and valve 7 until the normal ride height is attained.

If the operator fails to select "Ride" with valve 5 and also fails to reset valve 8 before driving off then his first application of the trailer service brake will cause valve 8 to revert. This exhausts the pilots of valves 9, 11, 12, 13 and these revert whereby the air springs are connected to the respective height control valves 6, 7 via valves 9, 11 and valves 12, 13 respectively. Again, the air springs are exhausted until the normal ride height is attained. A similar result is achieved if valve 5 is left selected in the "Raise Stop" condition and the valve 8 is reset manually before driving off, also if valve 5 has been left selected in the "Raise" condition. Thus the trailer platform is restored to its normal ride height from a raised position either before, or immediately as the trailer is driven away, irrespective of whether the operator wholly selects, partially selects, or fails to select the normal ride height condition and so avoiding damage to suspension and/or shock absorbers and/or air springs due to the trailer being driven with its platform in a raised condition.

Similarly, if it is required to lower the trailer platform on docking, the system which has been described also ensures that the platform is raised back to normal ride height before, or immediately as, the trailer is driven away. Thus, valve 8 is operated and valve 5 is moved to the "Lower" condition (fourth "box" from top). As before, this results in isolation of valves 6, 7 from the air springs and the latter are connected to atmosphere via valves 9, 12 and ports B, D and R of valve 5. When a "Lower Stop" selection (bottom "box") is made the ports B and D are blocked preventing further escape of air from the air springs.

When valve 5 is returned to the "Ride" condition the valves 6, 7 (now conditioned to inflate the air springs) are reconnected to the air springs which inflate via valves 6, 11, 5, 9 and valves 7, 13, 5, 12 because valve 8 has not been reset. Inflation ceases due to pressure air cut off by valves 6, 7 when normal ride height is attained.

Alternatively, if valve 8 is reset manually, or through application of the trailer service brake, whilst valve 5 remains in the "Lower Stop" condition the valves 9, 11, 12, 13 revert whereby the air springs are re-inflated to normal ride height via valves 6, 11, 9 and valves 7, 13, 12. This is also the inflation route if valve 5 is returned to the "Ride" condition, or if valve 5 has been left in the "Lower" condition instead of "Lower Stop".

Referring now to Figure 2, the valves 9, 11 and 12, 13 of Figure 1 have been replaced by valves 45, 46 respectively but the system operates in the same way as has been described with reference to Figure 1.

Turning now to Figure 3, the alternative "Raise/Lower" valve 5a has the same porting and connections as valve 5 of Figure 1 and for the "Ride", "Raise" and "Lower" conditions, and consequently for these selections, the system functions as has been described for Figure 1. When valve 5a is selected to the "Raise Stop" condition (top "box") all ports A, B, C, D, P and R are blocked, and similarly in the "Lower Stop" selected condition.

Considering the "Raise Stop" condition (following a "Raise" selection), if valve 8 is now reset, manually or as a consequence of operation of the trailer service brake, the valves 9, 11, 12, 13 revert. Since the valves 6, 7 are in the "Lower" condition the air springs are connected to atmosphere via valves 9, 11, 6 and 12, 13, 7 respectively until normal ride height is attained when valves 6, 7 return to the mid selection condition, cutting off any further outflow.

Similarly, when valve 5a is in the "Lower Stop" condition following a "Lower" selection and valve 8 is reset the valves 9, 11, 12, 13 revert. Valves 6, 7 are now in the "Raise" condition because the trailer platform is below the normal ride height and so the air springs are re-inflated via valves 6, 11, 9 and 7, 13, 12 to the normal ride height. If the valve 5a is fitted in the circuit of Figure 2 instead of valve 5 the operation is similar except that inflation/deflation of the air springs occurs through valves 45, 46 instead of valves 9, 11 and 12, 13.

Because the ports A, B, C, D, P and R are all blocked in the "Raise Stop" and "Lower Stop" selected conditions it is not necessary to include valves 11, 13 in the circuit. If these valves are omitted pipe 27 is connected to pipe 37 and pipe 25 is connected to pipe 41.

In the provision of a kit of components for retro-fitting to a trailer fitted with a conventional "Raise/Lower" system it may be desirable to supply the four valves (as 9, 11, 12, 13) so that the kit is suitable irrespective of whether a Raise/Lower valve as valve 5 or as valve 5a is fitted to the trailer.

Referring now to the drawing Figure 4, the valve 8 is again shown as having manual operation to cause a "Raise" or "Lower" selection of valve 5 (or valve 5a) to become effective. It may be desired to avoid taking a tapping from a trailer brake line, for example the service brake line, to cause resetting of the valve 8. Accordingly, in Figure 4 we provide a 3-way 2-position spring return solenoid operated pilot valve 51 and a relay switch 52 having an electrical power supply 50 thereto. Switch 52 is connected to the solenoid by a cable 56. The relay switch 52 is electrically connected by cable 54 to the trailer brake light circuit so that when the latter is energised a small proportion of the electrical power is used to operate the relay switch 52 and so cause energisation of the solenoid from supply 50 to operate valve 51.

Valve 51 is connected pneumatically to reservoir 4 via pipe 29 and to the pilot of valve 8 via a pipe 55. Valve 8 is connected to reservoir 4 via pipes 29, 53.

When the trailer brake is applied the brake light circuit is energised, operating valve 51 as has been explained. This causes reservoir 4 to be connected to the pilot of valve 8 via pipe 29, valve 51 and pipe 55 causing valve 8 to reset. As shown, resetting of valve 8 is effected by means of an electrical relay switch (52) so as to minimise the power drain from the brake light circuit. However, a preferred alternative is a direct operating low power solenoid valve 51 connected directly into the brake light circuit, eliminating the relay switch 52.

Referring to the drawing Figure 5, this is generally similar to Figure 1 and similar reference numbers are used where applicable. In view of this it will only be necessary to describe the different features of Figure 5.

The first valve means now comprises two manually operated spring return two position 3-way valves 61, 62. As is seen, the pressure air supply in pipe 23 is connected to valve 61 and pipe 63 connects valves 61, 62 and is connected to pipe 64. Pipe 64 is connected to pipes 28 and 26 which are connected to a respective valve 65, 66 comprising the second valve means. Height control valves 6, 7 are connected to valves 65, 66 by respective pipes 36, 39.

The pipe 43 is connected between the pilot for valve 8 and a solenoid operated spring return two position 3-way valve 67. A pipe 68 connects pipe 29 to valve 67. A cable 69 connects the solenoid of valve 67 to the brake light circuit of a vehicle to which the system is fitted, whereby a brake actuation energises the solenoid valve to admit pressure air from pipe 68 to pipe 43 to cause selector valve 8 to assume, or remain in, the condition shown in Figure 5.

The operation of this system will now be described. It is assumed that the various valves are in the condition shown with the trailer platform at its normal height, a tractor is connected to the trailer and the combination is parked on the tractor brake and reservoir 4 is charged with pressure air. If the tractor engine is running its compressor will be supplying pressure air to the trailer air suspension system via pipe 14 and filter 15.

It is desired to raise the trailer platform to level with a dock. Valve 8 is operated manually to admit pressure air from reservoir 4 through valve 8 and pipes 44 to the pilots of valves 65 and 66 whereby these valves change over. Valve 61 is then operated manually to the Raise condition. Pressure air now passes from reservoir 4 and/or the tractor compressor through valve 22 and valve 61 whence it passes through valves 65 and 66 to the air springs 1, 2, 3 and 1A, 2A, 3A extending them.

When the trailer platform rises to the desired height the valve 61 is released sealing the pressure air in the air springs. It will have been seen that the operation of valves 65 and 66 consequent on operation of valve 8, has disconnected the height control valves 6, 7 from their respective air springs, whereby the normal height control mechanism has been by-passed.

In the normal course of events the operator should either select "LOWER" with the Lower valve 62 or reset valve 8 manually before driving the trailer away from the dock. If he does the former, the air springs will be connected to atmosphere via valve 62 and pipes 63, 64, 26, 28, and if he does the latter the valves 65 and 66 will revert. The valves 6, 7 will be in their "Lower" conditions (top and bottom "boxes" respectively) and the air springs will exhaust to atmosphere via the reverted valves 65, 66 and valves 6, 7 until valves 6, 7 revert to the mid selection as the trailer platform lowers to the normal ride height.

If the operator selects "LOWER" with valve 62 but fails to reset valve 8 then valves 65, 66 remain in the operated condition. The air springs will exhaust via valve 65, valve 66 and valve 62 until the latter is released.

If the operator fails to select "LOWER" with valve 62 and also fails to reset valve 8 before driving off, then his first application of the trailer service brake will cause valve 8 to revert due to energisation of valve 67. This exhausts the pilots of valves 65, 66 and these revert whereby the air springs are connected to the respective height control valves 6, 7 via valves 65, 66 respectively. The air springs are exchausted until the normal ride height is attained. A similar result is achieved if the valve 8 is reset manually before driving off. Thus the trailer platform is restored to its normal ride height from a raised position either before, or immediately as the trailer is driven away, irrespective of whether the operator selects or fails to select the normal ride height condition and so avoiding damage to suspension and/or shock absorbers and/or air springs due to the trailer being driven with its platform in a raised condition.

Similarly, if it is required to lower the trailer platform on docking, the system which has been described also ensures that the platform is raised back to normal ride height before, or immediately as, the trailer is driven away. Thus, valve 8 is operated and valve 62 is moved to the "Lower" condition. As before, this results in isolation of valves 6, 7 from the air springs and the latter are connected to atmosphere via valves 65, 66 and valve 62.

When valve 62 is released deflation of the air springs ceases and the valves 6, 7 will be conditioned to inflate the air springs but remain cut off from the air springs until valves 65, 66 revert. If valve 8 is reset manually, or through application of the trailer service brake, the valves 65, 66 revert whereby the air springs are re-inflated to normal ride height via valves 6, 65 and valves 7, 66.

Referring now to Figure 6, this shows a modification to the circuit of Figure 5 and the same reference numerals are used to identify similar components. The modified circuit includes two additional 3-way 2-position pilot operated spring return valves 71, 72 and a double check valve 73. The pilots of valves 71, 72 are connected to check valve 73 by pipes 74, 75. Valve 62 is connected to pipe 21 by a pipe 76 and to check valve 73 by a pipe 77. Valve 61 is connected to valves 71, 72 and 73 by pipes 78, 79, 81, 82 and 83.

Following actuation of valve 8 (Figure 5), a Raise selection may be made by operating valve 61 and a Lower selection may be made by operating valve 62 (Figure 6).

Operation of valve 61 (subject to the condition of valve 22) admits pressure air to valve 73 through pipe 83. Valve 73 operates to seal pipe 77 and passes air to the pilots of valves 71, 72 via pipes 74 and 75. Valves 71, 72 operate to allow pressure air to pass through pipes 78, 79, 81, 82 and 28, 26 to the air springs 1, 2, 3 and 1A, 2A, 3A respectively. On release of valve 61 the pipes 78, 79, 81, 82 and 83 are vented through valve 61. Consequently, pipes 74, 75 are also vented and the valves 71, 72 revert, isolating the air springs 1, 2, 3 from the air springs 1A, 2A, and 3A and so maintaining roll stiffness of the vehicle in this platform raised condition.

Similarly, operation of valve 62 causes operation of valves 71, 72 by admitting pressure air to their pilots via pipe 77, valve 73 and pipes 74, 75. The air springs are now connected through valves 71, 72, pipes 82, 81, 79 and 78 to valve 61, through which they are vented. Release of valve 62 vents the pilots of valves 71, 72 and, as before, the air springs on each side of the vehicle are isolated by the valves 71, 72 to maintain roll stiffness of the vehicle.

Referring now to Figure 7, the same reference numerals are used as in Figure 5 and, where applicable, in Figure 6. There is now a Raise valve and a Lower valve for each side of the vehicle. The Raise valves are 90L and 90R and the Lower valves are 96 and 95. Valve 22 is connected to valve 72 via pipes 23, 91, valve 90L and pipe 92 and to valve 71 via pipes 23, 93, valve 90R and pipe 94.

Three way 2-position manually operated spring return valves 95, 96 are provided to effect operation of the pilots of valves 71, 72. Valve 95 is connected to pipe 21 via pipes 80, 97 and to one end of a shuttle valve 101 whose output is connected by a pipe 102 to the pilot of valve 71. The other end of shuttle valve 101 is connected to pipe 94. Valve 96 is connected to pipe 21 via pipe 80 and to one end of a shuttle valve 103 by a pipe 99. The output from valve 103 is connected to the pilot of valve 72 by a pipe 104. The other end of shuttle valve 103 is connected to pipe 92.

Raising the left hand side of the vehicle is effected by operating valve 90L. This admits pressure air via the shuttle valve 103 to the pilot of valve 72 to operate it so that pressure air passes from valve 90L through pipe 92 and valve 72 to the air springs 1A, 2A, 3A via valve 66 (Figure 5). Valve 90L is released to vent the pilot of valve 72 and the latter reverts to retain the pressure air in the springs 1A, 2A, 3A. Lowering of the left hand side of the vehicle is effected by operation of valve 96. This causes operation of valve 72 via shuttle valve 103 to connect pipe 26 to pipe 92 and the air springs 1A, 2A, 3A are vented via valves 66 and 90L, until valve 96 is released.

Similarly, valve 90R is operated to cause raising of the right hand side of the vehicle and valve 95 is operated to cause lowering of the right hand side of the vehicle.

Referring now to Figure 8, further alternative first valve means for the circuit of Figure 5 is shown. This comprises, for each side of the vehicle, two manually operated spring return two position valves 111, 112 and 113, 114.

Valve 111 receives pressure air from pipe 21 (Figure 5) via valve 22 (if fitted), pipe 23 and a pipe 115. A pipe 116 connects valves 111, 112 and pipe 116 is connected to pipe 28 (Figure 5).

Similarly, valve 113 receives pressure air from pipe 23 via a pipe 117. A pipe 118 connects valves 113,114 and is connected to pipe 26 (Figure 5).

Following operation of valve 8, operation of valve 111 causes extension of the air springs 1, 2, 3. Release of valve 111 and operation of valve 112 allows deflation of the air springs 1, 2, 3. Similarly, operation of valve 113 causes extension of the air springs 1A, 2A, 3A and operation of valve 114 allows deflation of these springs.

It will be seen that this construction allows elimination of the valves 71, 72 and shuttle valves 101, 103 of Figure 7.

It will be appreciated that the valve 8 may be operated remotely if desired, for example by cable operation or by electrical solenoid operation.

In the embodiments of the invention which have been described two height control valves 6, 7 are used. However, in many applications a single height control valve will suffice. Referring to Figures 1, 5 the ports E, F of valve 6 are connected to a pressure test point (X) and pipe 36 respectively and the ports G, H of valve 7 are connected to a pressure test

point (Y) and to pipe 39 respectively. If a single height control valve is fitted, for example valve 6, then pipe 36 would be connected to port E and pipe 39 to port F.

On Figures 1, 5 / pipes 57 (off pipe 38) and 58 (off pipe 39) are shown for connection to load sensing valves.

It will be appreciated that although this invention has been described by reference to a three axle installation it is equally applicable to, for example, single and twin axle installations.

In the practice of this invention various of the valves may conveniently be assembled or grouped in a single enclosure or box to be mounted on a vehicle. The box may have a lid which is sealed to prevent ingress of dirt. A check valve may be provided to vent the interior of the box in the event of a build up of pressure inside. The vent may be silenced. Pilot lines are preferably vented to the outside of the box so as to maintain internal integrity and prevent a build up of moisture. Provision may be made for a heater, for example an electrical heater, for low temperature operation.

Referring now to Figure 9, this illustrates schematically an arrangement of components in a control box for the system of Figure 5 as modified by Figure 8, the components being referenced as in Figures 5 and 8. Exhaust from the box is via a pipe 121 and an exhaust silencer 122. A one way vent, to relieve pressure in the box is referenced 123. Two or more valves may be manifolded to reduce space requirements and pipe connections in the box.

The components in the box may be chosen and arranged to suit the particular system required. For example for a retro-fit it will not be necessary to include a Raise/Lower valve as 5, 5a as this will already be present on the trailer, unless a complete Raise/Lower system is to be fitted to a trailer which does not have one. The invention thus also contemplates a kit of components (whether fitted in a box or for individual mounting on a trailer) for conversion of an existing trailer or for fitting in the build of a new trailer.

Claims

1. An air suspension system of the type described comprising, in pneumatic circuit, first valve means adapted to be connected to a pressure air supply and connected via second valve means to the air springs, the second valve means also connected to height control valve means whereby in a first condition of the second valve means the air springs are enabled to be inflated/deflated via the height control valve means and in a second condition of the second valve means the air springs are connected to the first valve means whereby the air springs may be inflated/deflated, remote operating means to cause the second valve means to be operated to the second condition, and a selector valve adapted to be connected to a pressure air supply and connected to the second valve means for remote operation thereof when said selector valve is operated to a first condition and means to operate said selector valve to a second condition whereby said second valve means is enabled to revert to its first condition in which inflation/deflation of the air springs is controlled by the height control valve means.

2. An air suspension system as claimed in Claim 1 wherein the means to operate said selector valve to its second condition comprises a pneumatically operated pilot.

3. An air suspension system as claimed in Claim 2 wherein pressure air is supplied to the pilot via an electrically operated pneumatic valve.

4. An air suspension system as claimed in Claim 2 wherein the pilot is adapted to be connected to a pneumatic brake line of a vehicle to which the system is fitted whereby the pilot is actuated when the brake is operated.

5. An air suspension system as claimed in Claim 3 wherein the electrically operated pneumatic valve is adapted for connection to a brake light circuit of a vehicle to which the system is fitted whereby said valve is actuated when the vehicle brake is operated.

6. An air suspension system as claimed in Claim 3 wherein the electrically operated pneumatic valve is supplied with electric power for actuation through a relay switch or like component which is adapted for connection to a brake light circuit of a vehicle to which the system is fitted, whereby said relay switch and consequently said valve are actuated when the vehicle brake is operated.

7. An air suspension system as claimed in any preceding Claim wherein the second valve means comprises, for each side of a vehicle to which the system is fitted, a pilot operated spring return two position three way valve said valve being connected to the first valve means, to the air springs and to the height control valve means.

8. An air suspension system as claimed in Claim 7 wherein the second valve means includes a second pilot operated spring return two position three way valve interposed between the three way valve of Claim 7 and the height control valve means and connected also to the first valve means.

9. An air suspension system as claimed in any one of Claims 1 to 6 wherein the second valve means comprises, for each side of a vehicle to which the system is fitted, a pilot operated spring return two position four way valve, two ways of said valve being connected to the first valve means one way connected to the height control valve means and one way connected to the air springs.

10. An air suspension system as claimed in any one of Claims 7, 8 or 9 wherein the first valve means comprises a manually operated five position six way valve having one way connected to a pressure air supply and one way connected to atmosphere and the remaining ways connected as set out respectively in Claim 7, or Claim 8 or Claim 9.

11. An air suspension system as claimed in any one of Claims 1 to 7 wherein the first valve means comprises first and second seletively operable spring return two position valves, said first valve adapted for connection to a pressure air supply and having a connection to said second valve, said second valve having a connection to atmosphere and the connection between said two valves connected to the valves of the second valve means, the arrangement being such that following operation of the selector valve to its first condition, operation of the first valve causes inflation of the air springs and operation of the second valve allows deflation of the air springs.

12. An air suspension system as claimed in any one of Claims 1 to 7 wherein the first valve means comprises, for each side of a vehicle to which the system is fitted, first and second selectively operable spring return two position valves, said first valve adapted for connection to a pressure air supply and having a connection to said second valve, which is also connected to

atmosphere, the connection between said two valves connected to a respective valve of the second valve means, the arrangement being such that, following operation of the selector valve to its first condition, operation of the first valve causes inflation of the air springs on the corresponding side of the vehicle and operation of the second valve allows deflation of the air springs on that side of the vehicle.

13. An air suspension system as claimed in any one of Claims 1 to 7 wherein the first valve means comprises first and second selectively operable spring return two position three way valves in combination with a shuttle valve and first and second pilot operated spring return two position valves, each selectively operable valve adapted for connection to a pressure air supply and having one way connected to atmosphere and one way connected to respective ends of the shuttle valve, the shuttle valve connected to the pilots of the pilot operated valves, each pilot operated valve having one way connected to a respective valve of the second valve means and one way connected to that end of the shuttle valve to which the first selectively operable valve is connected, the arrangement being such that operation of the first selectively operable valve admits pressure air to the shuttle valve whereby the pilots of the pilot operated valves actuate their respective valves to allow flow of pressure air therethrough from the first selectively operable valve to the second valve means and operation of the second selectively operable valve admits pressure air to the shuttle valve whereby the pilot operated valves are similarly actuated to allow flow of pressure air therethrough from the second valve means to atmosphere by way of the first selectively operable valve means.

14. An air suspension system as claimed in any one of Claims 1 to 7 wherein the first valve means comprises, for each side of the vehicle to which the system is fitted, first and second selectively operable spring return two position three way valves, said valves adapted for connection to a pressure air supply and connected to atmosphere, and a pilot operated spring return two position valve, the first selectively operable valve connected to the pilot of the pilot operated valve via a shuttle valve and the second selectively operable valve connected to the same pilot operated valve and to the pilot of that valve via the shuttle valve, the pilot operated valve also being connected to a respective valve of the second valve means, the arrangement being such that for each side of the vehicle operation of the first selectively operable valve admits pressure air to the pilot to actuate the pilot operated valve whereby pressure air is allowed to flow from the valve of the second valve means to atmosphere via the second selectively operable valve means and operation of the second selectively operable valve means admits pressure air to the pilot to actuate the pilot operated valve whereby pressure air is supplied to the valve of the second valve means whereby the air springs on each side of the vehicle can be deflated/inflated independently.

15. An air suspension system as claimed in any one of Claims 11, 12, 13 or 14 wherein the valves of the first valve means are manually operated.

16. An air suspension system as claimed in any preceding claim wherein the first and second valve means and the selector valve are mounted together in a single box.

17. An air suspension system as claimed in Claim 16 wherein a silencer is provided for pressure air being released to atmosphere from the system.

18. An air suspension system as claimed in Claim 16 or Claim 17 wherein a one way vent is provided to release to atmosphere any build up of pressure in the box.

19. An air suspension system substantially as described herein with reference to Figure 1 of the drawings or with reference to Figure 1 as modified by Figure 2 and or Figure 3 of the drawings.

20. An air suspension system as claimed in Claim 19 as modified by the drawing Figure 4 or by the modification of Figure 4 shown in Figure 5 of the drawings.

21. An air suspension system substantially as described herein with reference to the drawing Figure 5 or with reference to Figure 5 as modified by any of Figures 6, 7, 8 or 9.

22. A vehicle fitted with an air suspension system as claimed in any preceding claim.

23. A kit of parts for the purpose set out comprising remotely operable second valve means as set out herein, a two position selector valve operable by power means to at least one of said positions and conduit means to connect the selector valve to the remote operator of the second valve means and said parts adapted for connection in an air suspension system of the type described.

24. A kit of parts as claimed in Claim 23 in which the power means on the selector valve is a pneumatic pilot actuator and further comprising a low power solenoid operated two position pneumatic valve and means to connect said valve to said pilot actuator.

25. A kit of parts as claimed in Claim 23 or Claim 24 and further comprising first valve means as set out herein.

26. A kit of parts as claimed in any one of Claims 23 to 25 further comprising a box in which the parts are contained and connected as set out herein.

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